



TECHNISCHE UNIVERSITÄT  
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Master thesis

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## Organization of Second-Class Explosives “Amonal” and “Zayad”

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Dedicated to my beloved parents Serhii Shylin and Liudmyla Shylina

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## **Declaration of Authorship**

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“I hereby declare that this thesis is entirely my own work except where otherwise indicated. The presence of quoted or paraphrased material has been clearly signaled and all sources have been referred. The thesis has not been submitted for a degree at any other institution and has not been published yet.”

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## Acknowledgement

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In order to achieve a master's degree of mining in my life has been done a long way. I would like to express my gratitude to my supervisors Prof. Dr.-Ing. Helmut Mischo and Dr.-Ing. Jürgen Weyer for the useful comments, remarks and engagement through the learning process of this master thesis. Furthermore I would like to thank the participants in my survey, who have willingly shared their precious time during the process of interviewing. I would like to thank my loved ones, who have supported me throughout entire process, both by keeping me harmonious and helping me putting pieces together. I will be grateful forever for your love.

I appreciate highly organized program “AMRD” by prof. Bondarenko V.I., prof. Kowalewskaya I.A., prof. Drebenstedt C. and prof. Moser P.

I am grateful for the excellent mentoring of program Cherep A.Y., for providing repeated assistance throughout the period of study, moral support.

I am deeply grateful to my parents Shylin S.I. and Shylina L.V. for moral support, love, education, funding.

I want to express gratitude for the love and moral support to my wife Shylina Darya.

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## Abstract

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Over the past ten years, the Ukrainian market has established a tendency to displace patronized TNT explosives (PTE) by cartridge emulsion explosives (CEE). This led to the reduction in the share of PTE in the total amount of second-class cartridge explosives from 95% in 2007 to 25% in 2016, while the share of CEE increased from 5% to 75%, respectively. This trend is due to the lower cost of CEE (20% to 50%) relative to PTE.

The goal of the project is to preserve the positions of limited liability company «RPE Zarya» in the market of patronized explosives due to the production of new types of Second-class cartridge explosives with a reduced content of TNT - «AMONAL» and «ZaryaD».

Products «AMONAL» and «ZaryaD» are analogues of Ammonite 6ZhV, the content of trinitrotoluene in their composition is planned to be reduced to 16%, preserving the explosive properties at the same level. Reduction of the products cost is achieved by full or partial replacement of water-resistant ammonium nitrate with granulated ammonium nitrate of grade B.

Thus, the cost of these products is at the level of emulsion explosives costs, which used in the Ukrainian market, while marginal profitability of products remains at the level of 50-59%.

These products are intended to become the competitors in the Ukrainian market in terms of price-quality ratio in bulk and patronized emulsion explosives.

The placement of production of second-class cartridge explosives (SCCE) AMONAL and ZaryaD is planned on the basis of the existing production of ammonite 6ZhV (2006).

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### Main parameters of the project:

Total investment in the project	24.04 million UAH. 829 thousands euro
Source of investment financing	Own capital
Start investing	July 2017
Start of production	January 2018
Indicator of investment efficiency of the IRR project (2017-2023)	51%
Indicator of the present NPV value of the project (at the planning horizon of 7 years), million UAH.	25,132
Discounted payback period of investments, year (from the moment of the beginning of investment).	3,7
The payback period of the project without taking into account the discount rate, year	2,6



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## **1 General characteristics of the investment object**

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The object of investment is the second production point of LLC «RPE Zarya» (SCCE section). This site provides the production of SCCE «Ammonite №6ZhV». The existing circuit, including Korostelev's apparatus allows company to produce cartridges of only a certain diameter (32-36 mm). Considering the needs of the market, it is necessary to expand the range of patronized explosives produced at LLC «RPE Zarya».

The project provides modernization of the SCCE production and the acquisition of a new modern plant for the patronizing of explosives, which allows the production of cartridges with a diameter of 28 to 90 mm, depending on the configuration.

The investments aimed at covering the costs for the reconstruction of the existing scheme, the acquisition, installation and certification of modern equipment, the setting up of new types of industrial explosives (including control, preliminary and acceptance tests, expertise, technical approval, obtaining production licenses, etc.).

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## **2 The essence of the project**

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The major part of project's investment aimed to purchase a patronage device.

The delivery of the patronage device will be carried out according to the technical proposal of the company «Tehnex».

The volume of supply includes apparatus, hopper with feed screw, pneumatic clipping table, four nozzles (for cartridges with diameters 32, 42, 60 and 70 mm), markers and a set of spare parts.

The cost of the patronage device (including accessories) is 529.7 thousand euros, excluding VAT (value added tax). The delivery time of equipment is 10 months.

Reconstruction of the mixing and transportation system of explosives allows to increase the productivity of the scheme for the production of SCCE on the existing equipment from 4 to 7 tons per day.

In accordance with the legislation of Ukraine, the organization of the production of a new line of products of SCCE implies a long process of production setting. To obtain an admission to production and sale, newly developed products and equipment used in their production must pass a number of mandatory tests: control, preliminary and acceptance. Then, new products have to be included in the List of explosive materials for industrial use, the production and use of which are subject to licensing, then it must be certified and licensed.

In order to shorten the timeframe for the production of new products during 2017, it is planned to produce small-diameter cartridges (36 mm) of «ZaryaD» with the use of existing equipment - Korostelev's devices. Manufacture of large diameter cartridges (70 mm in polymer packing) «AMONAL» and «ZaryaD» will be done manually.

The products received in this way in 2017 will obtain all necessary tests and procedures provided by Ukrainian legislation, which will ensure the entry of new products to the market approximately by one year earlier.

The new patronage apparatus delivered in September 2017. In the first half of 2018 will be done such points as: construction and installation, commissioning and control, preliminary and acceptance testing of newly commissioned equipment in accordance with the current legislation. Production beginning of «AMONAL» and «ZaryaD» on the new device planned in July 2018.

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### **3 Project's target products**

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«AMONAL» and «ZaryaD» are Second-class cartridge explosives. They are typical representatives of the class of ammonites. They are non-safety industrial explosives of medium power. They used to conduct blasting operations in open and underground mining operations, except of mines that are dangerous for gas and dust.

RPE «Zarya» plans to produce products in the form of cartridges (diameters 32, 36, 42, 60 and 70 mm) and in powder form.

Mass of cartridges: from 200 g to 2000 g.

Index	Rate
1. Mass fraction of moisture,%, not more than	2,0
2. Density of explosive in the cartridge, g/cm <sup>3</sup>	1,05±0,1
3. Brilliance, mm, not less than	10
4. Transmission of detonation at a distance between dry cartridges, cm, not less than:	
- in a diameter of 32 mm	2
- in diameter of 50 mm	6

Table 1. Physical, chemical and explosive indexes of «AMONAL»

The explosive characteristics of the new types of SCCE (detonation velocity, detonation transfer between cartridges) are not inferior to the characteristics of «Ammonite №6ZhV», which is important for consumers using standard TNT-containing SCCE.

The main advantages of the «ZaryaD» SCCE in front of the patented emulsion explosives are: higher values of such indicators as the transfer of detonation between cartridges (~ 2 times), the volume of gases (by 5-11%), the explosion temperature (~ 32%), providing the best indexes for mining with the same financial costs for the explosive implementation.

Index	Rate
1. Mass fraction of moisture,%, not more than	0,5
2. Density of explosive in the cartridge, g/cm <sup>3</sup>	1,1±0,1
3. Brilliance, mm, not less than	14
4. Water resistance on the hydrodynamic device, cm, not less than	40
5. Transmission of detonation at a distance between dry cartridges, cm, not less than:	
- in a diameter of 32 mm	5
- in diameter of 50 mm	7
6. Detonation transfer to the distance between the cartridges after soaking in water, cm, not less than:	
- in a diameter of 32 mm	3
- in diameter of 50 mm	5

Table 2. Physical, chemical and explosive indexes of «ZaryaD»

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## 4 Analysis of the project production

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Over the past ten years, the Ukrainian market has established a tendency to displace patronized TNT explosives (SCCE) by cartridge emulsion explosives (CEE). This led to a decrease in the share of Ammonite 6ZhV in the total amount of SCCE from 95% in 2007 to 25% in 2016, while the share of CEE (Ukrainit and Anemix) increased from 5% to 75%. This trend is due to the lower cost of Ukrainit and Anemix (from 20% to 50%) relative to Ammonite №6 ZhV.

To preserve the positions and ensure the competitiveness of the products of LLC «RPE Zarya» on the Ukrainian market, it proposed to introduce an alternative product to the market. To do this it needs:

- To develop a new product («ZaryaD») with such characteristics (explosive characteristics, price, safety, reliability) that will ensure its competitiveness with respect to Ammonite №6 ZhV and emulsion formulations.

- To carry out the replacement of Ammonite No. 6 ZhV by «ZaryaD» in the segment of SCCE Ø 32 mm (excluding VostGok) and occupy 65% of the segment.

- Enter the SCCE segment Ø 42, 70 mm with a new product («ZaryaD») and take ≈ 34% and 60% respectively.

- In total, the total volume of products estimated at ~ 1920 tons or ~ 101.2 million UAH (3.24 million EUR). At the same time, the company needs to invest in the creation of a new product and its withdrawal to the market, which will require additional financial resources.

- The option with the launch of a new product on the market is more promising in the long run, it reflects the activity of the enterprise in the market and allows us to get a product with a greater life cycle than Ammonite 6ZhV.

## 4.1 The volume and structure of the Ukrainian SCCE market

Currently, in the total volume of second-class explosives used in Ukraine, the SCCE occupy ~ 2.55% (3.65 thousand tons) in physical terms and 11.4% (203.8 million UAH; 6.76 million EUR) in monetary terms. (cp. Marketing department, 2017)

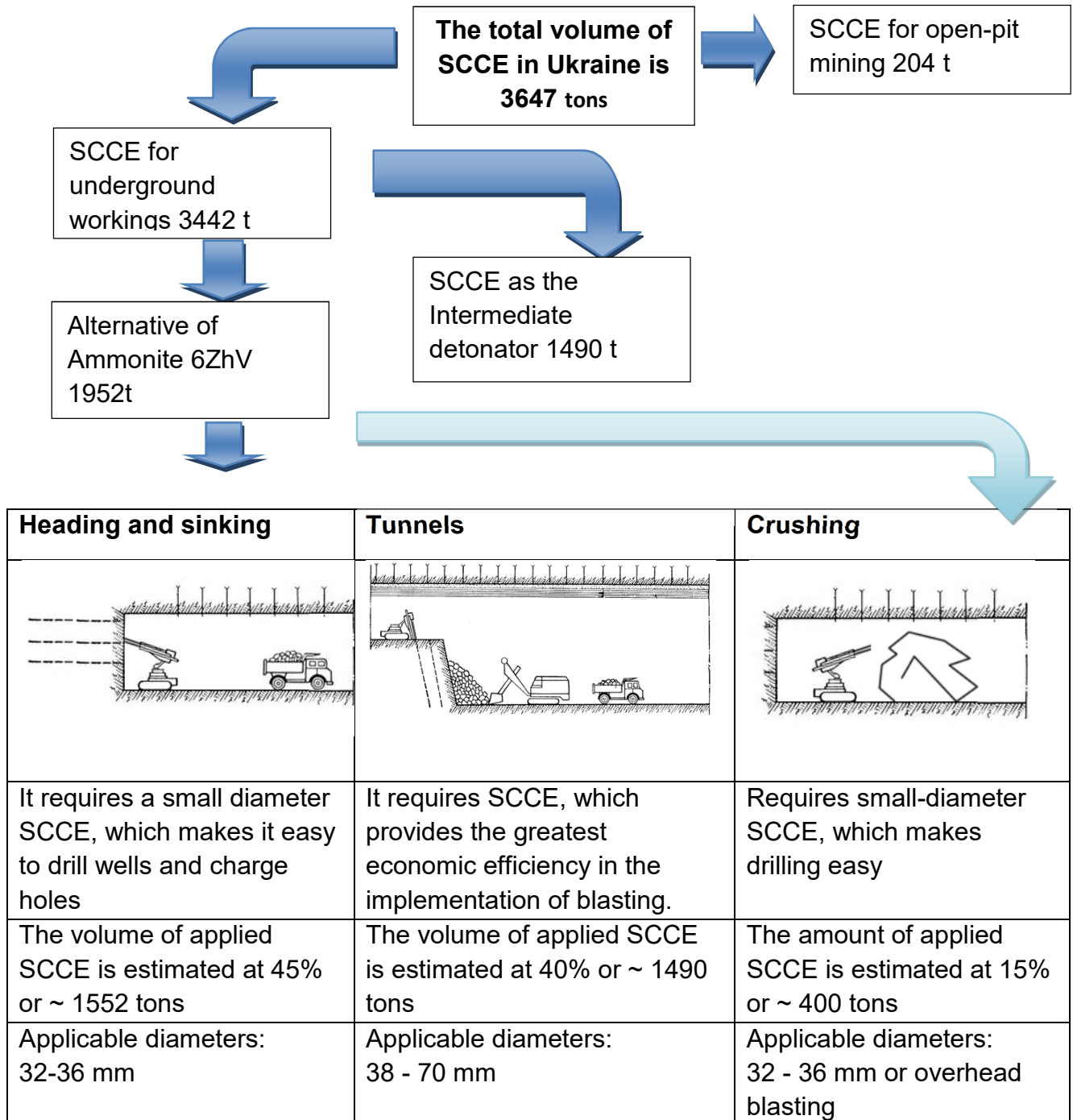


Figure 1. The volume and structure of the Ukrainian SCCE market

RPE «Zarya» produces Ammonite 6ZhV only with a diameter of 32-36 mm, which makes it possible to participate in mine heading and sinking with crushing of oversized pieces of rocks and excludes participation in tunnel workings. This factor turns Ammonite 6ZhV into a niche product with a maximum sales volume of up to 2,000 tons.

The enterprise «Promvzryv» is the leader in sales of SCCE in Ukraine and occupies 2/3 of the total volume of the market. This position of the company is due to the availability of technology for the production of modern explosives (the «Ukrainit P» product) at an affordable price. These are the geographical proximity to the blasting sites, the historically established cooperation with customers in not only the field of product supply, but also the development of new explosives, the understanding of all stages of the blasting by the company's specialists.

Structure of the Ukrainian SCCE market looks like:

Structure of the Ukrainian SCCE market in the context of producers in 2016 (Total: 3647 tons)

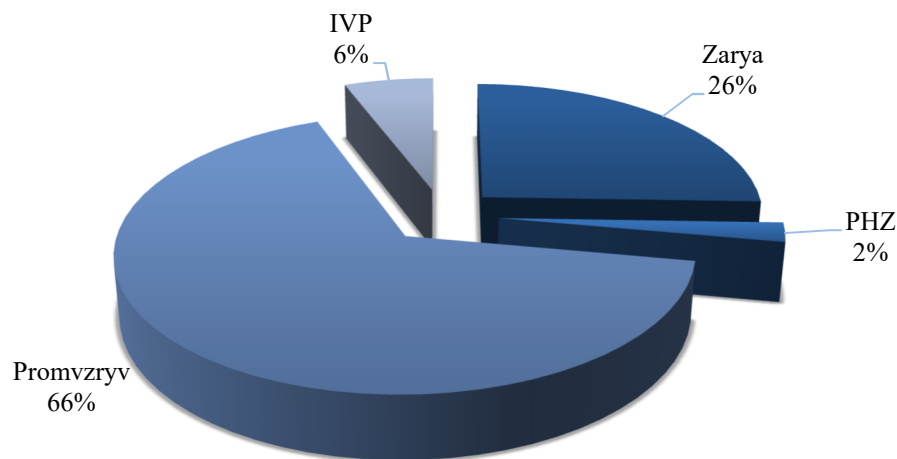


Figure 2. Structure of the Ukrainian SCCE market in the context of producers in 2016

Structure of the Ukrainian SCCE market by diameters  
(Total: 3647 tons)

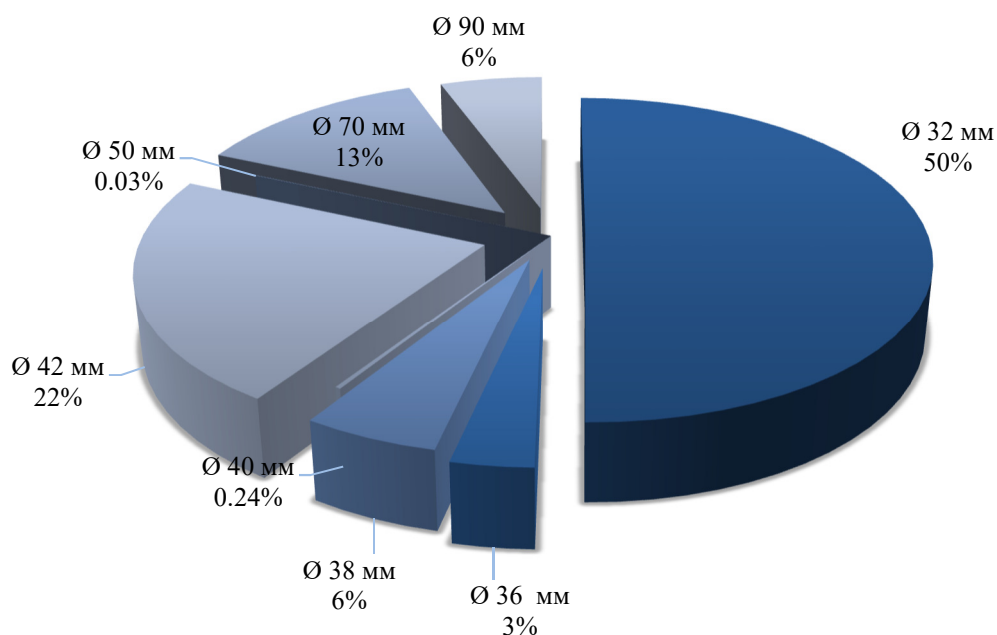


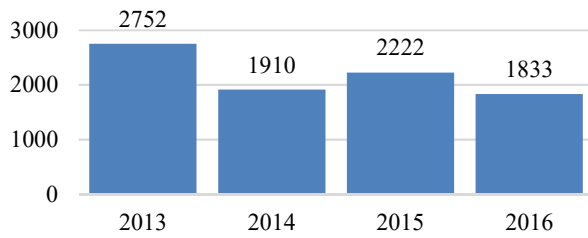
Figure 3. Structure of the Ukrainian SCCE market by diameters (cp. Analytical Department, 2016)

In 2016, foreign trade activities for the supply of SCCE in Ukraine was not carried out and all consumption in the country is covered by the expense of a domestic product.

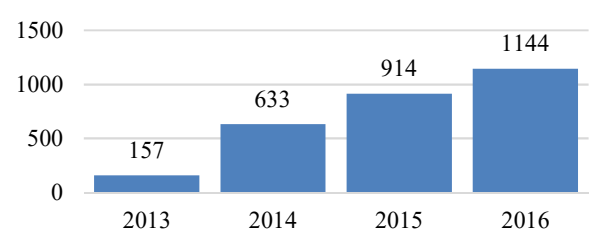
The most capacious segment of the Ukrainian market of SCCE is cartridges with a diameter of 32-42 mm. This segment of the market estimated at 2940 tons (87% of the total volume) per year or 188 million UAH (6.26 million EUR, 88% of the total volume). These types of explosives used at all enterprises engaged in drilling and blasting operations. The most attractive customer is “Krivbassvzryvprom”.

From 2013 to 2016 the volume of the Ukrainian SCCE market grew by 21% from 3,012 tons to 3,646 tons. All segments of SCCE except of Ø32, demonstrate the growth dynamic. In the Ø32 segment, the reduction occurred only due to a decrease in Ammonite 6ZhV production volumes (-53%), while cartridge emulsion explosives showed positive dynamics (+ 57%).

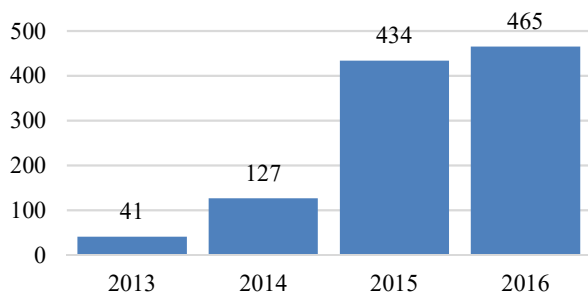
**Dynamics of SCCE production  
Ø 32, t**



**Dynamics of SCCE production  
Ø 38-42, t**



**Dynamics of SCCE production  
Ø 70, t**



**Dynamics of SCCE production  
Ø 90, t**

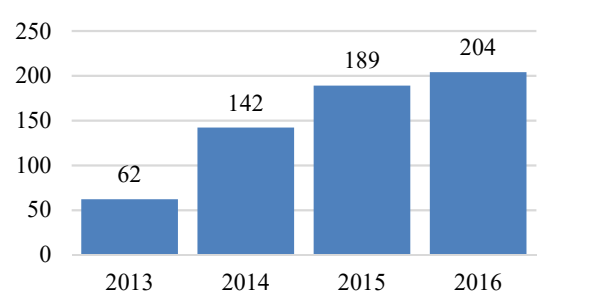


Figure 4. Dynamics of SCCE production

As the dynamics of production shows, the segment Ø 38-42 mm and Ø 70 mm demonstrates the greatest growth, where the increase was 7.5 times and 11 times, respectively. LLC RPE «Zarya», as a market participant does not have a product for these segments, this problem can be solved at the expense of a new product - «ZaryaD».



Consumer	Producer			
	Zarya	PHZ	PV	IVP
PJSC «Krivoy Rog Iron Ore Combine»	34,78		1039,45	6
State Enterprise «Eastern Mining and Processing Enterprise»	542			
PJSC «Evraz Suhaya Balka»			519,32	
PJSC «Zaporozhye Iron Ore Combine»			514,49	
PJSC «Krivorozhdorvzryvprom»			252	
PJSC «ArcelorMittal Kryviy Rih»	70			69,79
PJSC «Mine Management» Pokrovskoe»	105,86			
PJSC «Krivbassvzryvprom»			59,7	35,28
PJSC «Central Mining and enrichment plant»	23,98		33	
<b>Other</b>	154,04	84,2	1,94	101,5
<b>TOTAL:</b>	<b>930,66</b>	<b>84,2</b>	<b>2419,9</b>	<b>212,57</b>

Table 3. Deliveries of SCCE, 2016

## 4.2 Main competitors

Competitors, product	Competitive advantages to LLC RPE «Zarya»
Intervzryvprom, Anemix-P	A product created with world experience and knowledge. Possibility to supply all diameters. The lowest price on the market in the segment of Ø 32, 70 mm. Geographical location and proximity to customers. Offer a set of equipment (machines), in addition to explosives. Presence of an emulsion.
Promvzryv, Ukrainit-P	The most popular product on the Ukrainian market. A product created with world experience and knowledge. Cooperation with major consumers in product's improvement. Possibility to supply all diameters. Geographical location and proximity to customers. Wide geography of supplies. Presence of a bulk emulsion.
Pavlograd Chemical Plant, Era-R-III	Possibility to supply all diameters. Geographical location and proximity to customers. Presence of a bulk emulsion

Table 4. Main competitors

### 4.3 Price positioning

In 2016, the price of 1 ton CEE was in the range of 40-56.04 thousand UAH. Price 1 t. TNT was in the range of 65-95 thousand UAH.

The price situation in the Ukrainian market of SCCE as follows:

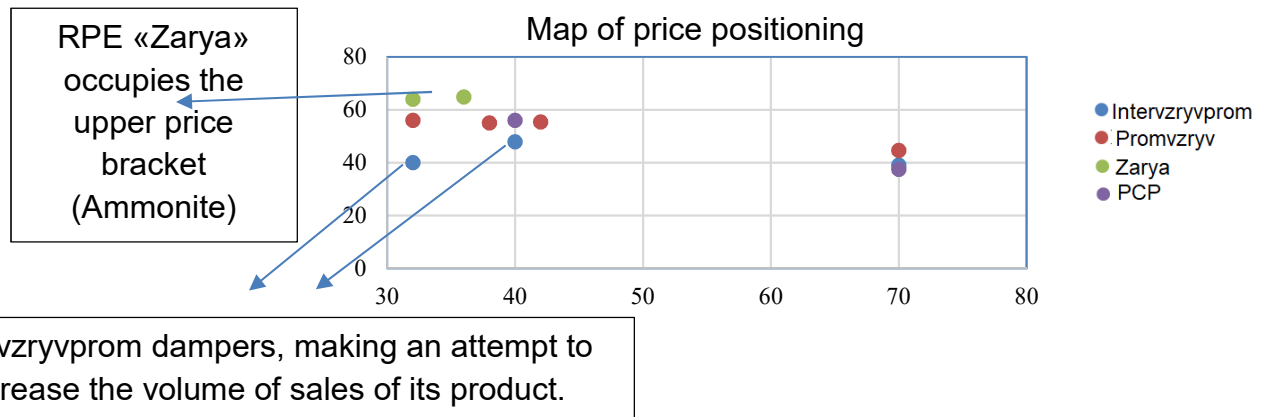


Figure 5. Map of price positioning

Enterprise	Using explosives	Price thousand UAH/t (without VAT)
Central mining and processing plant	Ukrainit P-CA 32/250	55.1
	Ammonite № 6ZhV/32	83.3
PJSC «Evraz Suhaya Balka»	Ukrainit P-CA 32/250	54.1
	Ukrainit P-CA 42/300	54.1
PJSC «Krivoy Rog Iron Ore Combine»	Ukrainit P-CA 32/250	55.5
	Ukrainit P-CA 38/300	55.5
	Ukrainit P-CA 42/300	55.5
	Ammonite № 6ZhV/32	95
PJSC «Zaporozhye Iron Ore Combine»	Ukrainit P-CA 32/200	56.04
	Ukrainit P-CA 38/300	56.04
	Ukrainit P-CA 42/500	56.04
	Ukrainit P-CA 90/2500	56.04
PJSC «Krivbassvzryvprom»	Ukrainit P-CA 42/600	44.6
	Ukrainit P-CA 70/800	44.6
	Ukrainit P-CA 70/1800	44.6
	Anemix P70/900	40.0
ArcelorMittal	Ammonite № 6ZhV/32	64.9
	Anemix P32/200	40.0
	Anemix P70/900	40.0
State Enterprise «Eastern Mining and Processing Enterprise»	Ammonite № 6ZhV/32	63.8

Table 5. Prices of SCCE in Ukraine in 2016

It can be seen that in the Ukrainian market of SCCE there were three price categories:

- Price of TNT Ø32-36 mm, the highest level of prices in the market and is at the level of 64 thousand UAH. and higher;
- Price of CEE Ø32-42 mm, ≈ 15% cheaper than SCCE, is 49-55 thousand UAH;
- Price of CEE Ø70 mm, ≈ 30% cheaper than SCCE, is 40-46 thousand UAH.

LLC RPE «Zarya» is not profitable to supply its products due to the dumping, because it can lead to the market drop in monetary terms. In order to obtain additional advantages and delivery of a new product, it is necessary to reduce the price for new types of SCCE by 5-10% of the value of Promvzryv's products. Taking into account the price of «ZaryaD», the price map (without Ammonite 6ZhV) will look like this:

Map of price positioning

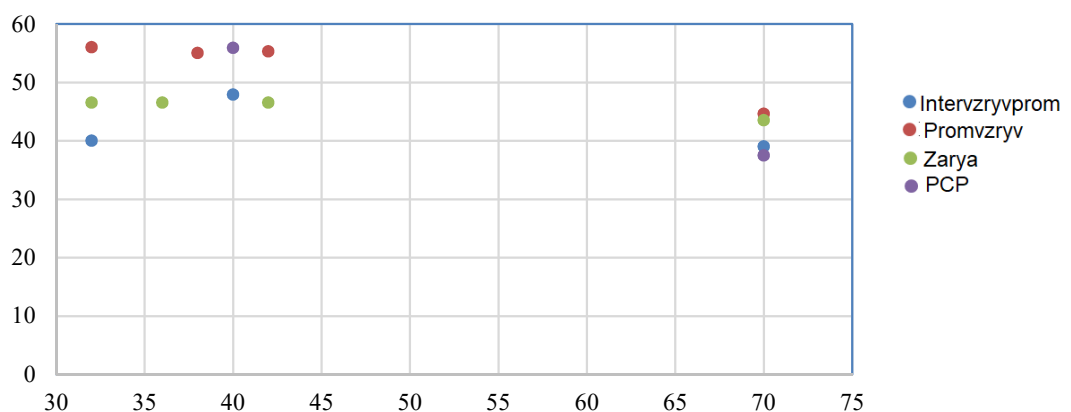


Figure 6. Second map of price positioning

Thus, LLC RPE «Zarya» in the derivation of «ZaryaD» will face with tough competition both technical and price. The market is distributed, and competition with competitors is possible due to the economic effectiveness of the product.

## 4.4 Main Customers

As the structure of the Ukrainian market of SCCE shows, iron ore mining companies are the main consumers and occupy ~ 70%.

Structure of the Ukrainian market of SCCE in the context of consumers in 2016 (Total: 3,647 tonnes)

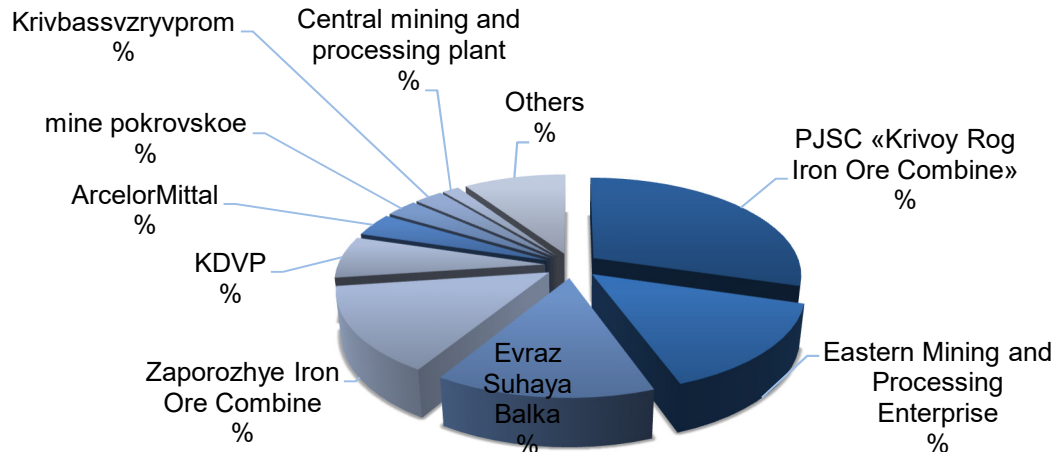


Figure 7. Structure of the Ukrainian market of SCCE

Enterprise	Consumption volume of SCCE		Potential share of RPE Zarya	
	tons	Million UAN	tons	%
PJSC «Krivoy Rog Iron Ore Combine»	1080	61,3	756	70
State Enterprise «Eastern Mining and Processing Enterprise»	542	34,5	0	0
PJSC «Evraz Suhaya Balka»	520	28,8	104	20
PJSC «Zaporozhye Iron Ore Combine»	515	28,6	0	0
KDVP	252	11,2	0	0
ArcelorMittal	140	7,3	98	70
Mine Pokrovskoe	105	6,8	105	100
PJSC «Krivbassvzryvprom»	95	4,1	0	0
Central mining and processing plant	57	3,8	46	80
Others	341	17,5	273	80
<b>TOTAL:</b>	<b>3647</b>	<b>204</b>	<b>1380</b>	<b>34</b>

Table 6. Forecast of the implementation of the «ZaryaD» SCCE in 2020 in the context of consumer enterprises

The development of «ZaryaD» in the market will take place at the expense of the current customers of LLC RPE «Zarya» (consumers of Ammonite 6ZhV), the amount consumed by them is sufficient for the development of the product until 2019.

In 2019-2020 for further increase of the implementation volume, it is necessary to attract new customers. To maintain the dynamics of growth in sales it is necessary to act proactively and in 2018 work on attracting of new customers.

All consumers can be divided into the groups:

- Explosive industry: enterprises carrying out blasting operations to third parties: «Krivbasvzryvprom», «Krivorozhdorvzivprom», «Zapaddor-explosion», «Spetsvzryvprom», «Buropodryvnik», «Ekobalt», «Tekhrazrabotka», «Ukragrovzryvprom»;
- Mining and processing plant and Quarries: «Vostokok», «Suhaya Balka», «Marganetsky GOK»;
- Mines: SE «Krasnolimanskaya», mine «Pokrovskoe», SE «Toretskugol», enterprises of the group «Arcelor Mital»;
- Specialized organizations: «Kievmetrostroy», «Ukrtehnostroy», «Zarya-mashproekt»;
- Metals and factories: “Arcelor”, “Azovstal”, “Zaporizhstal”.

The most promising groups are Mining and processing plant and Quarries, as well as specialized organizations. The first group provides the largest volumes of consumption of products; the second group is ready to purchase small volumes of products at a higher price. LLC RPE «Zarya» should focus on these groups of enterprises.

The most important indicators for which consumers guided when selecting SCCE are:

#### **Operational indicators**

- Detonation velocity
- Brisance
- Fugacity
- Transmission of detonation
- Sensitivity
- Waterproof

#### **Consumer features**

- Price
- Safety (during transport and operation)
- Ease of use
- Output of rock mass
- Environmentally friendly product
- Completeness of detonation

## 4.5 Forecast of changes in the blasting market until 2020

According to the forecast of the American experts of the Chicago Mercantile Exchange, by 2019 the prices for iron ore raw materials in the world market will decrease by 35% or from \$45 to \$29, which connected with the price policy of China and the restoration of the Brazilian company Samarco. For Ukrainian iron ore producers, this means that 2017-2020 will be quite complex and a high level of profit should not be expected.

At the same time, the company Metinvest expects the increase of pellets and large-lump ore demand by 20% on the world market to 2020 year. A similar forecast made in the company «Ferrexpo». Both companies will continue to make investments that will increase the production capacity of the mills, which will also positively influence the volume of blasting in Ukraine.

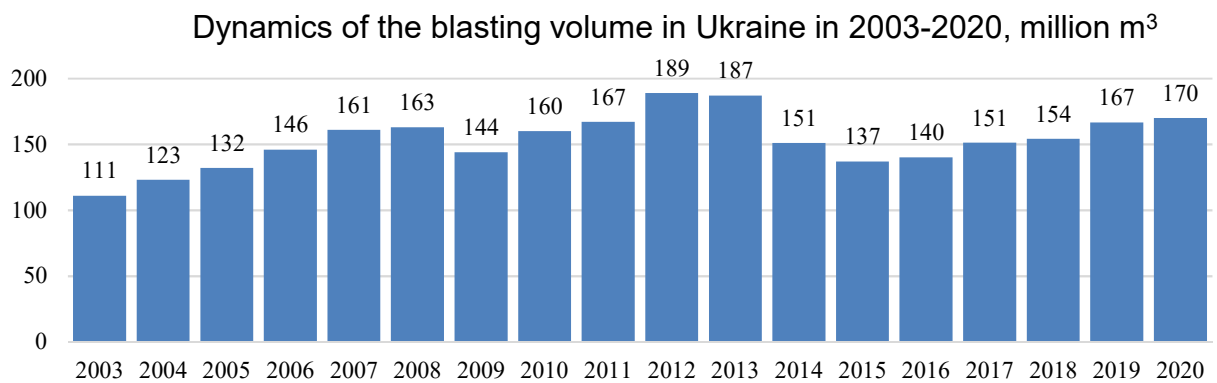


Figure 8. Dynamics of the blasting volume in Ukraine in 2003-2020

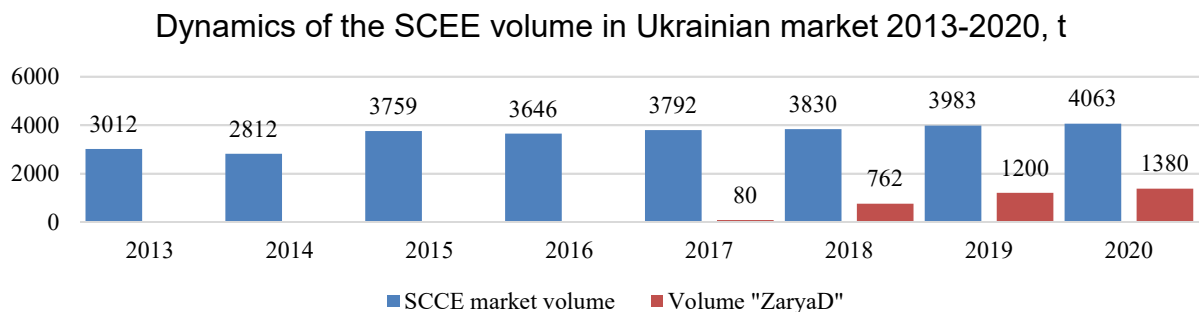


Figure 9. Dynamics of the SCEE volume in Ukrainian market 2013-2020

Forecast for «ZaryaD» on the Ukrainian SCCE market %

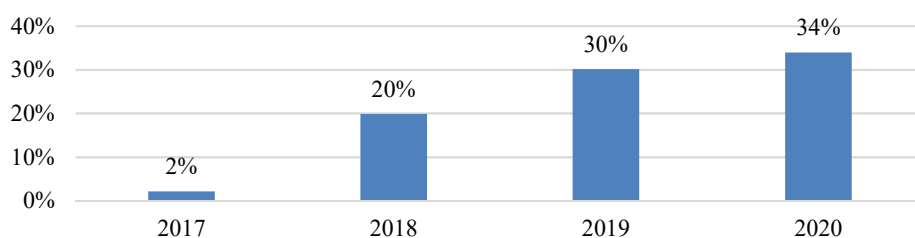


Figure 10. Forecast for «ZaryaD» on the Ukrainian SCCE market

The political situation in the country will have a significant impact on the investment volume of Metinvest and Ferrexpo. If the situation becomes worse the investment plans will not be fully implemented or not be completed, which will significantly influence on the forecast.

#### 4.6 SWOT analysis of SCCE ZaryaD

<p><b>Strong</b></p> <ul style="list-style-type: none"> <li>➤ New product on the market.</li> <li>➤ Explosive characteristics at the level of Ammonite.</li> <li>➤ Wide range of diameters.</li> <li>➤ Cost at the level of competitors, margin of profitability.</li> <li>➤ Waterproofing in polyethylene packaging is higher than Ammonite.</li> <li>➤ Can be used as an intermediate detonator</li> </ul>	<p><b>Weak</b></p> <ul style="list-style-type: none"> <li>➤ Powder explosives in paper packaging are inferior to emulsion in watered conditions usage.</li> <li>➤ Lack of related products in the line (checkers, detachable cords, machines, detonators).</li> <li>➤ Insecurity and difficulty in retrieving TWI failures.</li> </ul>
<p><b>Capabilities</b></p> <ul style="list-style-type: none"> <li>➤ Growing market of SCCE consumption</li> <li>➤ The market is distributed among Ukrainian companies</li> <li>➤ There are no global corporations on the market of blasting in Ukraine (business consolidation as a perspective).</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>➤ Economic and political situation in Ukraine.</li> <li>➤ Fall of the blasting market in Ukraine.</li> <li>➤ Military operations in the eastern region.</li> <li>➤ Possible dumping from competitors.</li> <li>➤ Mergers and acquisitions of small companies by large one and multinationals. It creates threats for company both as a supplier of explosives and a niche producer.</li> </ul>

Table 7. «ZaryaD»: Strong and weak sides, opportunities and threats

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## 4.7 Marketing tools for the withdrawal/promotion of «Zaryad» SCCE

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- Price competition - the price is lower than competitors by 5-10%.
- Testing with a discount (personal) for accumulating of positive feedback.
- The offer of the assortment («Ammonite 6ZhV», «ZaryaD», a wide range of cartridge diameters).
- Conducting comparative tests, both internal and external based on customers with products of competitors.
- Advertising support at exhibitions and conferences from the moment of the appearance of the product and passing the tests.
- Registration of TM «ZaryaD».

Actions for the access to the market of ZaryaD can be seen in Table 8. (see: Annex p. I)

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## 4.8 AMONAL SCCE market

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«AMONAL» SCCE is a product developed specifically for the market of eastern and northern Europe.

Second-class CE (cartridge explosives) in Europe produced based on secondary TNT, the reserves of which reduced annually. In this connection, there is a tendency of substitution of SCCE by CEE. On the other hand, this opens up the possibility of entering the market with a product with lower TNT content than Ammonite, in the markets of Bulgaria, Poland, Serbia, Slovakia, Scandinavian countries for a producer that has its own cheap raw materials and the opportunity to form a loyal price for SCCE. Such a manufacturer may become LLC RPE «Zarya».

Potential consumers:

At present, a number of European companies are interested in cooperation with LLC RPE «Zarya» in the field of supplies of explosives of the second class.

These companies are Delta Defens (Slovakia), STV-groups (Czech Republic), EPC (UK).

Marketing department further investigates more accurate volume data.



LLC Delta Defense - the owner of technology and equipment for the production of explosives Polonit (analogue Ammonite) and Donavit (safety explosives), own technology for the production of emulsion patronized explosives and nitroglycerin.

STV Group - has extensive experience in the explosives market in the Czech Republic, the Balkan countries and the EU. The company offers an exclusive partnership in the field of cartridges and CEE production. They have experience in developing their own plant for the production of explosives for wet and dry wells under trademark Emonit.

EPC (UK) is one of the world's suppliers of explosives and operators of blasting, which has several divisions, including blasting, and fuel additives. The first offered bulk explosives in the British market. This is one of the consumers of TNT. According to marketing department data, TNT from Poland is imported at a volume of 50 tons per year. The company supplies bulk explosives, has its own Multiline brand, advanced logistics and supplies the entire range of blasting services in the UK and the world. It is part of the EPC-group, which is the leading supplier of global blasting at bauxite mines, the only player in the production of civilian explosives in Saudi Arabia and the most powerful distributor of explosives in West Africa.

According to information provided by potential consumers, the market volume is about 1000 tons per year.

The declared amount of AMONAL consumption is 400-500 tons per year. (cp. Commercial department, 2017)

## 4.9 Brief analysis of the EE market in Ukraine

In the period from 2006 to 2015, The consumption of EE increased from 50 thousand tons to 100 thousand tons per year. Up to 2012, the growth rate was about 20% per year. Since 2013, there has been a drop in growth rates and in 2014 there has been a 20% drop in its share due to the political crisis and the armed conflict in the East of Ukraine. The forecast of EE consumption in 2018 will be 105 thousand tons.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Anemix	13741	18676	14000	33644	32650	36000	38000	38400	32643	29705	30299
Emonit	3330	12538	22000	31376	34855	40797	44852	44000	35642	32434	33083
Ukrainit	33000	40095	48000	35199	41068	41000	47853	46000	32935	29971	30570
Era	-	710	1152	1885	4120	4400	5652	4800	4343	3952	4031
Granemit	-	-	-	-	4652	5400	5800	5300	5500	5005	5105
<b>Total</b>	50071	72019	85152	102104	117345	127597	142157	138500	111063	101067	103088
Increase rate		44%	18%	20%	15%	9%	11%	-3%	-20%	-9%	2%

Table 9. Consumption of EE in Ukraine for 2006-2016, tons (cp. Marketing Department)

Consumption of EE in Ukraine in 2015 amounted to 74% of the total number of used explosives. The share of emulsion explosives, such as «Anemix», «Emonite» and «Ukrainit», is approximately the same and is about 22% for each species. On «Granemite» and «Era» account for 4 and 3% respectively, the share of other types of explosives is 26%.

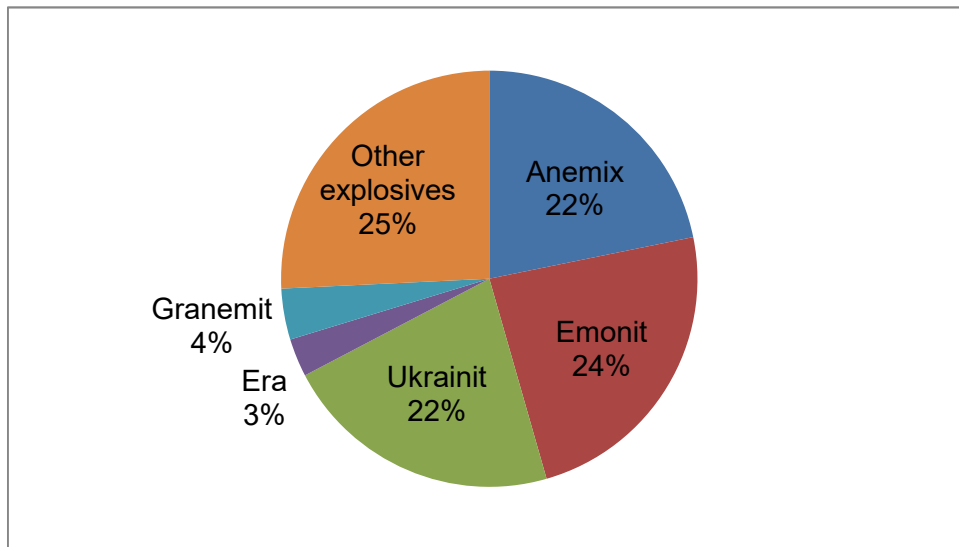


Figure 11. Structure of EE consumption by types in Ukraine in 2016

The patronized EE accounts less than 1% of the EE market and nowadays they have not replaced the intermediate TNT detonators, which for many decades have confirmed their reliability. This trend will continue in the future. Perhaps other modifications of the ID based on a mixture of cast/pressed TNT, hexogen or plastid will appear on the Ukrainian market. The market of Ukraine's ID today is estimated at no less than 600 tons per year. 2/3 of this market is now represented by patronized EE, 1/3 - TNT.

The largest Ukrainian producers-consumers of EE are LLC «Krivbassvzryvprom» and CJSC «Intervzryvprom».

#### 4.10 Comparison of explosives Zaryad and Ukrainit

In general, existing emulsion explosives intended for the production of blasting by small-diameter boreholes, either not such, or have low explosive and operational characteristics that are unsatisfactory to the requirements of mining enterprises.

Emulsion explosives, which are currently capable of replacing the existing ammonite 6ZHV, have in their composition costly components, including foreign production, as well as expensive energy additives, including from individual explosives or from fire-hazardous substances that increase not only the heat of the explosion, but also the danger of existing production of industrial explosives.

Explosive indicators of EE are directly dependent on the mass fraction of water in the composition of the emulsion matrices and the explosives themselves.

Explosive indicators of EE are directly dependent on the mass fraction of water in the composition of the emulsion matrices and the explosives composition.

The input of porous granular ammonium nitrate in the composition of emulsion explosives up to 25.0% makes it possible additionally to artificially reduce the mass fraction of water in the composition of the EE, reduce the density of the explosive composition, and bring the oxygen balance to zero.

Zero oxygen balance ensures maximum energy release of explosive transformation of EE and minimal formation of toxic constituents of gaseous products of the explosion.

Characteristics	Index	
	Ukrainit	Zaryad
Estimated		
Oxygen balance, %	from -0,05 to -4,3	minus 2,87
Heat of explosion, kcal/kg	4100-4400	891
Specific volume of gases in products of explosion, l/kg	721-750	940
Explosion temperature, K	743	2359
Trotyl equivalent for heat of explosion	0,61	0,9
Detonation velocity, km/s	4,3-4,4	3,9
Critical diameter of detonation of open charge, mm:	12-15	12-13

Table 10. Comparison of explosives Zaryad and Ukrainit

The Ukrainit composition consists of domestic products only. The production of EE and charging of wells is carried out based on the existing domestic production base. These circumstances, as well as the lack of expensive and environmentally dangerous TNT inside of the EE, provide a significant reduction in costs for explosive rock crushing and accelerate the transition of quarries to the widespread use of environmentally friendly, waterproof and highly effective explosives.

The composition of Ukrainit is highly designed, it means that during the explosion the degree of completion of chemical reactions reaches 97%. In the explosion cloud, there are mainly water vapor, carbon dioxide and free nitrogen.

The composition of emulsion explosives does not include materials classified as explosives. They acquire explosive properties only in the final stage of preparation. EE are practically insensitive to accidental initiation from friction, mechanical influences or fire and are safer in production than other industrial explosives. In addition, they do not contain highly toxic substances.

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#### **4.11 Preliminary conclusions**

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«ZaryaD» is able to compete in price with CEE, which is very important for the consumer.

«ZaryaD» - a product that must extend the life cycle of TNT-containing explosives.

«ZaryaD» - powdered explosives, this fact limits the popularity of the new product and requires an evidence base for the promotion to the market with the involvement of clients and reference groups at the first stage. It is important to allocate additional consumer benefits (quality characteristics) under which the charge can effectively replace Anemix and Ukrainit.

The promotion of «ZaryaD» will allow to keep the position of LLC «RPE Zarya» for existing customers and enter the niche of underground tunnel workings.

For a full promotion of SCCE «ZaryaD», it is necessary to improve the quality of sales support services (quality component). The analyst of the quality management department confirms this.

The price positioning for «ZaryaD» is defined as 44 to 47 thousand UAH.

According to the information provided by potential consumers, the volume of the European SCCE market is approximately 1000 tons per year. Deliveries of «AMONAL» SCCE to potential consumers are planned at the level of 400-500 tons/year (cp. Analytical department, 2017).

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## 5 Production

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The main stages of the production process of patronized explosives:

- preparation and drying of components;
- grinding and mixing of components;
- sifting and transporting the powdered product;
- patronage (in polymer or paper shell);
- marking of cartridges;
- packaging of the finished product.

Patronization of products will be carried out in several ways:

- with the use of Korostelev's devices («ZaryaD» Ø36 mm);
- manually (patronage of large diameters (70 mm) when staged for production);
- using new equipment (from July 2018).

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### 5.1 Organization of production

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The production of new types of SCCE will be carried out in building 2. The production process is planned as follows:

➤ During 2017, the production of small-diameter cartridges of «ZaryaD» with the use of existing equipment - Korostelev's is planned. Manufacture of large diameter ammunition «AMONAL» and «ZaryaD» was done manually. The products thus obtained in 2017 will pass all the necessary tests, which will ensure the timely entry of new products to the market.

In December 2017, a new apparatus for patronage was delivered.

➤ In the first half of 2018 - construction, installation, commissioning, control, preliminary and acceptance testing of newly commissioned equipment in accordance with the current legislation. The launch of «AMONAL» and «ZaryaD» on the new device is planned for July 2018.

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## **5.2 Ensuring production**

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In 2017, the forces of personnel working in the current production will provide the production of new brands of SCCE. In the second half of 2018, 11 workplaces must be additionally organized to service the patronage device, taking into account the growth in the production of SCCE. Compulsory insurance of personnel by law is not required. Instead of insurance, personnel receive a bonus for hazardous and harmful working conditions, according to the labor legislation of Ukraine.

The Quality Control Service (QCS) of LLC RPE «Zarya», which has the necessary technical equipment and a highly qualified staff, will carry out quality control of raw materials and finished products for compliance with regulatory documents.

To ensure the uninterrupted operation of production, it is planned to carry out preventive and capital repairs, in accordance with regulatory and technical documentation.

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## **5.3 Production volumes**

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The plan of second-class cartridge explosives production for 2017 – 2020 can be seen in table 11. (see: Annex, p. II)

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## **5.4 Risks in production**

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The risks in the production of new types of SCCE are typical technical risks of this production. Measures to manage technical risks will be taken into account in the design, installation and acceptance of equipment, in technological regulations, in the system of inspections by supervisory organizations, in the training system and periodic personnel certification.

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## 5.5 Depreciation (leasing) of the fixed assets of the project

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To implement this investment project, financial resources are required 24.04 million UAH (0.8 million EUR) with VAT, of them for equipment 21.1 million UAH with VAT (17.6 million UAH without VAT).

Depreciation charges are calculated by a straight-line method. The depreciation period was adopted at the level of 12.5 years (the average depreciation period for the equipment).

Category of fixed assets	Depreciation period	Depreciation method	Initial cost, thousand UAH. without VAT	The amount of accruals for the year, thousand UAH. without VAT
New equipment	12,5 years	rectilinear	17610,9	1408,9

Table 12. Depreciation of fixed assets

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## 5.6 Production cost for products of the project

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Tables 13-15 show planned calculations of the cost of ammonium nitrate, SCCE «AMONAL» and «ZaryaD» (diameter of cartridges 32 and 42 mm) for 2020. (see: Annex, p. III-V)



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## 6 Procurement and provision of resources

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### 6.1 Resources required for production

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The commercial management of LLC RPE «Zarya» carries out the provision of raw materials.

To implement this project and obtain the planned results, the following raw materials are required (according to the production plan for 2020)

<b>Main resources</b>	<b>Demand, tons per year</b>
<b>Raw materials</b>	
Wood flour	10,2
Ammonium nitrate	1540
Carboxymethyl cellulose (CMC)	2,2
Calcium stearate	13,8
Oxide of iron	4,3
Paraffin	1,4
<b>Semi-finished products</b>	
TNT brand A	282

Table 16. The necessity of raw materials and semi-finished products to support the production plan in 2020.

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## 7 Organization of activities

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### 7.1 Obtaining permits and licenses

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To organize the production of «AMONAL» and «ZaryaD», it is necessary to obtain a number of permits and licenses. The cost of issuing the necessary permits given in Table 17. (see: Annex, p. VI-VII)

## 7.2 Organizational structure

The organizational structure of production formed in accordance with the standards operating at the enterprise.

## 7.3 Staffing schedule

Job design category	Rank	number of staff	hourly wage rate	annual fund of working time per unit	annual tariff, salary	Additional payme .	annual salary fund, UAH	Award	payroll fund with a premium	Insuranc e payment
pelleting machine worker (1 person/shift + 1 swap)	5	6	26,05	1 756,80	274 587,84	123 454,49	398 042,33	95 007,39	493 049,72	108 470,94
worker for preparing raw materials and dispensing semifinished products (5 people/shift + 2 swings)	4	22	23,21	1 756,80	897 057,22	290 232,69	1 187 289,91	310 381,80	1 497 671,70	329 487,78
worker for preparing raw materials and dispensing semifinished products (5 people/shift + 2 swings)	3	21	21,32	1 756,80	786 554,50	271 233,39	1 057 787,88	272 147,86	1 329 935,74	292 585,86
Total		49			1 958 199,55	684 920,57	2 643 120,12	677 537,04	3 320 657,17	730 544,58

Table 18. Labor intensity of the main workers of the production of SCCE, 2017 (36 hour working week, 4 interchangeable work schedules, 5 brigades)

job design category	Rank	numb er of staff	hourly wage rate	annual fund of working time per unit	annual tariff, salary	Additio nal payme .	annual salary fund, UAH	Award	payroll fund with a premium	Insurance payment
pelleting machine worker (1 person/shift + 1 swap)	5	6	26,05	1 756,80	274 587,84	123 454,49	398 042,33	95 007,39	493 049,72	108 470,94
worker for preparing raw materials and dispensing semifinished products (5 people/shift + 2 swings)	4	27	23,21	1 756,80	1 100 933,86	354 711,93	1 455 645,78	380 923,11	1 836 568,90	404 045,16
worker for preparing raw materials and dispensing semifinished products (5 people/shift + 2 swings)	3	27	21,32	1 756,80	1 011 284,35	342 307,78	1 353 592,14	349 904,39	1 703 496,52	374 769,23
Total		60			2 386 806,05	820 474,20	3 207 280,25	825 834,89	4 033 115,14	887 285,33

Table 19 - Labor intensity of the main working class of the production of SCCE, second half of 2018 (36 hour working week, 4 interchangeable work schedules, 5 brigades)

*Note: Newly introduced units: a 5-digit apparatus (5 units, 1 person/shift) and a 4-digit hardware unit (6 units, 1 person/shift + 1 substitute)*

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## 7.4 Payment of personnel

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Since the structural divisions of LLC RPE «Zarya» will carry out the activity on production and sale of products of the project, the parameters of the payment of personnel will correspond to the policy of payment of labor at the enterprise.

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## 7.5 Risks in the organization of activities

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Organizational risks are possible when implementing a project and production of products. The reasons for the risks and measures to mitigate their consequences presented in Table 20. (see: Annex, p. VIII-IX)

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# 8 Investments in the project and financing of investments

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## 8.1 The need for a project in investment

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In order to realize all project activities, investments for 24040 thousand UAN needed.

<b>Cost item</b>	<b>Amount, ths. UAH with VAT</b>
1. Losses on raw materials, energy for the production of experienced parties	189
2. Development of design documentation	80
3. Examination of the project	62
4. Purchase of cartridge installation (including bunker, table, cuffs, marker, spare parts, commissioning works)	18633
5. Reconstruction of the system of transportation and mixing of explosives	2 500
6. Certification of the cartridge for explosion protection and application	300
7. Primary inspection of equipment	50
8. Costs of raw materials, energy for working out, testing and utilization of experienced parties	97
9. Conducting control tests of products and equipment	359

10. Determination of uncontrolled product performance	192
11. Preliminary and acceptance testing of products and equipment	430
12. Examination and approval of TT	80
13. Licensing documentation	215
14. Certification	364
15. Obtaining a production license (Gostrud)	8
16. Travel expenses	179
17. <i>Unforeseen costs</i>	300
<b>TOTAL:</b>	<b>24 040</b>

Table 21. Structure of investments for the organization of production of SCCE «AMONAL» and «ZaryaD»

*Note: The data presented in Table 21 is approximate and will be refined after the development of design documentation, carrying out of the summary calculation of the construction object, its complex examination, processing of applications for equipment and the conclusion of relevant contracts.*

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## 8.2 Financial risks of the project

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The financial risks that may arise in implementing the project (currency and other), the sources (causes) of these risks, possible measures to mitigate the effects of these risks, assess the «cost» of these measures - costs and their impact on the economy of the project are presented in Table 20. (see: Annex, p. VIII-IX)

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## 9 Project Risks and Risk Management

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This section presents the most significant risks of the project in terms of their impact on the implementation of the project and the return on investment. Accordingly, measures to mitigate these risks and manage these risks are the key objectives of the management of LLC RPE «Zarya» during the implementation of the project and operating activities. (see: Annex, p. VIII-IX)

## 9.1 Scenarios of the project

In the present business plan, the baseline scenario for project implementation and operating activities of LLC RPE «Zarya» is considered. The parameters of the scenario shown in Table 22.

Parameters and characteristics	Baseline scenario
<b>Investment parameters</b>	
Amount of investment, mln. UAH.	24,04
Discount rate of cash flows, %	20
Beginning of investment development	January 2017
<b>Operating parameters</b>	
Volumes of production	According to the production plan (Table 11)
Start of production and sales	July 2017
«AMONAL»	900-1200
«ZaryaD»	1450-1550

Table 22. Scenario parameters

In calculating the return on investment, profits from the sale of new types of products «AMONAL» and «ZaryaD» of all types of packaging are taken into account.

The cost of new equipment is taken into account in the form of depreciation charges in the cost of production, which will be manufactured with its use («AMONAL» Ø32, 42, 60 mm and «ZaryaD» Ø32, 42, 70 mm), distributed in proportion to the volume of output (starting from the second half of 2018 g.).

In calculating the gross profit of the project, the costs for processing substandard SCCE formed at the stage of patronage when working on the Korosteleva machine (2.07% of the production volume, according to the actual data of the technical department for 2016, the cost of processing 1t was 3206.7 UAH/t).

Calculation of all cost indicators (both cost and revenue) according to the plan for the period 2017-2020. was carried out on the basis of the values included in the calculation of the business plan for 2017 (the cost of raw materials, semi-finished products, auxiliary materials, energy resources, payroll, general workshop costs, exchange rates, margin level of products, volume and profitability of services, etc.) possible inflationary processes.

## 10 Financial projections and economic indicators of the project

Financial project forecasts are presented in standard forms of financial reporting on business activities - forecast of revenues and costs, project profit and loss, projection of project cash flows, project balance forecast. For this project, it is not necessary to form a separate balance sheet, as production and sales will be organized within existing companies. For assessing the effectiveness of investments, forecasts of operating profit and cash flows are given. Planning horizon is 7 years.

### 10.1 Forecast of project income and expenses, profit and loss.

Baseline scenario	2017	2018	2019	2020	2021	2022	2023
Sales (without VAT)	4 060	41 679	64 676	72 555	72 555	72 555	72 555
Direct costs	2 259	20 992	31 458	34 537	34 537	34 537	34 537
General production costs	1 986	11 726	15 739	16 310	16 310	16 310	16 310
Depreciation	0	704	1 409	1 409	1 409	1 409	1 409
Production cost	4 245	33 422	48 606	52 256	52 256	52 256	52 256
Processing costs substandard SCCE	4	7	11	12	12	12	12
Gross profit	-189	8 250	16 059	20 287	20 287	20 287	20 287
Income Taxes	0	1 404	2 732	3 451	3 451	3 451	3 451
Net financial result	-189	6 852	13 338	16 848	16 848	16 848	16 848
Profitability of sales,%	-5	16	21	23	23	23	23

Table 23. Forecast of income and expenses of the project, profit and loss, ths. UAH

### 10.2 Project cash flow projections

Baseline scenario	2017	2018	2019	2020	2021	2022	2023
Cash flow for investment activities	-24 039						
Net financial result	-189	6 852	13 338	16 848	16 848	16 848	16 848
Depreciation	0	704	1 409	1 409	1 409	1 409	1 409
Cash flow from operating activities	-189	7 557	14 747	18 257	18 257	18 257	18 257
Net DP for the year	-24 227	7 557	14 747	18 257	18 257	18 257	18 257

Table 24. Project cash flow projections, ths. UAH

### 10.3 Economic indicators of the project

A generalized indicator of the economic efficiency of the project is the payback period of investments on discounted cash flows. This indicator is derived from the indicators «internal rate of return of the project» (IRR) and «net present value of the project» (NPV). Calculations of economic indicators presented in the table:

<b>Baseline scenario</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>
Investments, thousand UAH.	24 039						
Annual cash flow, thousand UAH.	-24 227	7 557	14 747	18 257	18 257	18 257	18 257
IRR, % 2017-2023 r.r.	51%						
Discount rate, %	20%						
Discount coefficient	1,00	0,833	0,694	0,579	0,482	0,402	0,335
Discounted CF, thousand UAH.	-24 227	6 297	10 241	10 565	8 804	7 337	6 114
Accumulated DCF, thousand UAH.	-24 227	-17 930	-7 689	2 876	11 680	19 017	25 132
PI	2,0						
NPV, thousand UAH. (2017-2023 r.r.)	25 132						
Payback period on DCF, years	<b>3,73</b>	<b>September 2020 r.</b>					

Table 25. Economic efficiency of the process

## 11 Conclusion

In order to maintain the position of LLC RPE «Zarya» in the Ukrainian market of explosives, it is planned to organize the production of new types of SCCE with a reduced content of TNT -»AMONAL» and «ZaryaD» of different diameters, in demand by potential consumers. Within the framework of the project, the acquisition of a patronage device planned for the release of these products.

The approximate amount of investments for the organization of production is 24.04 million UAH. (829 thousand euros).

The discounted payback period of the project is 3.7 years from the beginning of the investment.

The payback period of the project, excluding the discount rate, is 2.6 years from the beginning of the output.

With a planning horizon of 7 years, the net present value of the project (NPV) will be 25,132 million UAH.

The business project on the organization of production of SCCE «AMONAL» and «ZaryaD» is short-term and meets all selection criteria adopted at the enterprise.

Product «ZaryaD» designed to replace the product ammonite 6ZhV in the domestic Ukrainian market; the buyers of the product now have already compared «ZaryaD» and Ammonite 6ZhV. Now, RPE «Zarya» is installing the final equipment for setting up the production of the «ZaryaD» product. Actually it had great marketability, would be great to use in the future, and would bring in a lot of money for the enterprise.

«ZaryaD» is a powdered explosive, this fact limits the popularity of a new product, and an evidentiary base is needed to promote the market with the involvement of clients and reference groups at the first stage. At the same time, it is important to allocate additional consumer benefits (quality characteristics) under which RPE «Zarya» can effectively replace competitors' products.

Withdrawal of «ZaryaD» will save the positions of RPE «Zarya», for existing customers, and enter the niche of underground tunnel workings.

The mission of «ZaryaD» is to be a transitional product, the purpose of which is to support the business until reinvestment into new directions/products.

The next stage after the development of the market will be the local production of emulsion explosives.

By producing higher quality products and pricing them competitively, our team increase the marketability of this product by consumers wanting to choose our product over equally priced item with less quality.

For the second-class explosives, there is certainly a huge chance to become a key product in the Ukrainian market, due to explosive characteristics and a price comparable to emulsion explosives, also due to the replacement of Ammonite 6ZhV. At the same time, «ZaryaD» considered at the enterprise as a temporary product for the time of development and testing of emulsion explosives, since the emulsion is much less emission of hazardous gases into the atmosphere, in the long term. According to forecasts it will be cheaper, much easier to use and safer, which is very important for enterprises.

At the same time, the product «AMONAL» has a chance to be recognized on the market only in case of preliminary orders (mainly this product is bought for resale), as it was created as a product abroad, because of the considerable transportation cost. Considering that Ukrainian enterprises do not trade explosives with Russia, the price of logistics and obtaining permits, as well as a huge number of analogs, do not give RPE «Zarya» the chance to enter the international market.



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## Abbreviations

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LLC – Limited Liability Company

RPE – Research production enterprise

PTE – patronized TNT explosives

CEE – cartridge emulsion explosives

SCCE – second-class cartridge explosives

QCS – Quality Control Service

EE – Emulsion explosives

ID – intermediate detonators

TT - Technical Terms

## Annex

### Actions

<b>Actions</b>	<b>Stage 1, March 2017- October 2017</b>	<b>2 stage, November 2017- December 2018</b>	<b>Stage 3, January 2018-January 2019</b>
Work with consumers, the formation of experts' opinion (explosives, miners) at the stage of product birth. Trips to consumers. Collect feedback from consumers (and design)	April-May	Systematically: 1 time per quarter, feedback forms	Forms of feedback, trips once every six months for all consumers
Conducting comparative tests at LLC «RPE «Zarya», with products Anemix, Ukrainit	May-June	Diameter tests	Comparative tests of updated products
Video shooting of tests, preparation of a commercial for a new product	May-July		Updating of video
Formation of the experts' opinion (reference groups)	May-August		Continuous updating
Presentation of the product, production start. Conference	May-October	To exhibitions and conferences	For exhibitions, conferences, updates
Analysis of the competitive environment in Ukraine	always	Always	Always
Collection of information at exhibitions and conferences about analogs and CEE	May-October	During the year, not less than 2 years	At least 2 per year including international
Connecting national media for promotion	September	October	When new products are introduced
Preparation of promotional materials for sales support	May-October		Regular updating once a quarter

Table 8. Actions for the access to the market of "ZaryaD"

### Plan of Production

Name	Diameter of the cartridge, mm	2017 year	2018 year	2019 year	2020 year
<b><i>Korostelev's Apparatus</i></b>					
Amonite 6 ZhV	32	909	800	544	544
Amonite GF-5K	36	127	180	180	180
ZaryaD	36	64	100	160	180
<b><i>Manual method of patronage</i></b>					
AMONAL	70	16	16		
ZaryaD	70	16	32		
<b><i>Powdered product</i></b>					
Amonite 6 ZhV	packing - bag	144	128	100	96
AMONAL	packing - bag		25	50	25
<b><i>New apparatus for patronage</i></b>					
AMONAL	32		8	8	16
AMONAL	42		8	8	16
AMONAL	60		200	300	300
ZaryaD	32		300	560	640
ZaryaD	42		130	240	280
ZaryaD	70		200	240	280
Total, tonnes:		1276	2127	2390	2557

Table 11. Plan of SCCE production for 2017-2020, t/year

## Production cost

	Naming of expenditures	unit	Ammonium nitrate (dried) 2020 z				
			for 1 ton		for the whole issue in a year		
					quantity	sum	
	Sales price, without VAT	UAH/t				uan	eur
	<i>Revenues from sales</i>	<i>UAN</i>				<i>0</i>	<i>0</i>
	Releas	t/year			1 510,0		
<b>1</b>	<b><u>Variable costs</u></b>			<b>8 289,16</b>		<b>12 516 635</b>	<b>431 608</b>
<b>1.1</b>	<b><u>Raw materials</u></b>			<b>6 190,48</b>		<b>9 347 628</b>	<b>322 332</b>
	Ammonium nitrate	tonnes	1,020	6 190,48	1 540,2	9 347 628	322 332
		price	6 069,10				
<b>1.2</b>	<b><u>Semifinished products</u></b>			<b>0,00</b>		<b>0</b>	<b>0</b>
<b>1.3</b>	<b><u>Auxiliary materials</u></b>	<b>UAN</b>		<b>200,00</b>		<b>302 000</b>	<b>10 414</b>
<b>1.4</b>	<b><u>Steam power engineering</u></b>			<b>1 898,68</b>		<b>2 867 008</b>	<b>98 862</b>
	Electricity	kw	80,0	149,28	120 800	225 413	7 773
		price	1,866				
	Technical water	m3	15,0	60,60	22 650	91 513	3 156
		price	4,0403				
	Steam common	Gcal	1,3	1 637,84	1 963	2 473 144	85 281
		price	1 259,88				
	Compressed air	nm <sup>3</sup>	66,0	50,95	99 660	76 938	2 653
		price	0,772				
<b>2</b>	<b><u>Fixed costs</u></b>			<b>2 154,29</b>		<b>3 252 978</b>	<b>112 172</b>
	Wage	UAN		203,00		306 530	10 570
	Salary Charges	UAN		44,66		67 437	2 325
	General shop costs	UAN		1 906,63		2 879 011	99 276
	Depreciation (for rent)	UAN		0,00		0	0
	<b>PRODUCTION COST</b>			<b>10 443,45</b>		<b>15 769 613</b>	<b>543 780</b>

Table 13. Calculation of the cost price of ammonium (dried) nitrate.

	Naming of expenditures	Unit	(AMONAL) diameter 32, 42 mm 2020 year				
			for 1 ton		for the whole production per year		
					quantity	sum	
					UAN	EUR	
	Sales price, without VAT	UAN/t	1200	34 800,00			
	Revenues from sales	UAN				1 113 600	38 400
	Releas	t/year			32,0		
<b>1</b>	<b>Variable costs</b>			<b>17 854,50</b>		<b>571 344</b>	<b>19 702</b>
<b>1.1</b>	<b>Raw materials</b>			<b>656,44</b>		<b>21 006</b>	<b>724</b>
	Wood flour	kg	4,2	30,87	134,4	988	34
		price	7,35				
	carboxymethyl cellulose	kg	6,3	517,73	201,6	16 567	571
		price	82,18				
	Calcium stearate	kg	2,1	107,84	67,2	3 451	119
		price	51,35				
<b>1.2</b>	<b>Semifinished products</b>			<b>14 349,51</b>		<b>459 184</b>	<b>15 834</b>
	Dried ammonium nitrate	tonnes	0,896	9 353,68	28,7	299 318	10 321
		price	10 443,45				
	TNT	tonnes	0,142	4 995,83	4,5	159 867	5 513
		price	35 243,96				
<b>1.3</b>	<b>Auxiliary materials</b>	UAN		<b>2 425,19</b>		<b>77 606</b>	<b>2 676</b>
<b>1.4</b>	<b>Steam power engineering</b>			<b>423,36</b>		<b>13 548</b>	<b>467</b>
	Electricity	kW	140,0	261,24	4 480	8 360	288
		price	1,866				
	Compressed air	n/m <sup>3</sup>	210,0	162,12	6 720	5 188	179
		price	0,77				
	<b>Marginal profit</b>			<b>16 945,50</b>		<b>542 256</b>	
	<b>Marginal profitability</b>			<b>48,7%</b>		<b>48,7%</b>	
<b>2</b>	<b>Fixed costs</b>			<b>12 013,60</b>		<b>384 435</b>	<b>13 256</b>
	Wage	UAN		1 436,06		45 954	1 585
	Salary Charges	UAN		315,93		10 110	349
	General shop costs	UAN		9 450,51		302 416	10 428
	Depreciation (for rent)	UAN		811,10		25 955	895
	<b>PRODUCTION COST</b>		<b>1030</b>	<b>29 868,10</b>		<b>955 779</b>	<b>32 958</b>
	<b>Gross profit</b>		<b>170</b>	<b>4 931,90</b>		<b>157 821</b>	<b>5 442</b>
	<b>Gross profitability</b>			<b>14,2%</b>		<b>14,2%</b>	

Table 14. Calculation of the cost of AMONAL d = 32, 42 mm



	Naming of expenditures	Unit	(ZaryaD) diameter 32.42 mm 2020				
			For 1 ton		For the whole production per year		
					quantity	sum	
					UAN	EUR	
	Sales price, without VAT	UAN/t	1550	44 950,00			
	<i>Revenues from sales</i>	UAN				41 354 000	1 426 000
	Releas	t/year			920,0		
<b>1</b>	<b>Variable costs</b>			<b>18 281,49</b>		<b>16 818 967</b>	<b>579 964</b>
<b>1.1</b>	<b>Raw materials</b>			<b>624,17</b>		<b>574 239</b>	<b>19 801</b>
	Wood flour	kg	6,3	46,31	5 796,0	42 601	1 469
		price	7,35				
	Oxide of iron	kg	3,2	56,73	2 898,0	52 193	1 800
		price	18,01				
	Calcium stearate	kg	9,5	485,26	8 694,0	446 437	15 394
		price	51,35				
	Paraffin	kg	1,1	35,88	966,0	33 008	1 138
		price	34,17				
<b>1.2</b>	<b>Semifinished products</b>			<b>14 923,76</b>		<b>13 729 862</b>	<b>473 444</b>
	Dried ammonium nitrate	tonnes	0,862	9 002,78	793,1	8 282 556	285 605
		price	10 443,45				
	TNT	tonnes	0,168	5 920,99	154,6	5 447 306	187 838
		price	35 243,96				
<b>1.3</b>	<b>Auxiliary materials</b>	UAN		<b>2 310,19</b>		<b>2 125 375</b>	<b>73 289</b>
<b>1.4</b>	<b>Steam power engineering</b>			<b>423,36</b>		<b>389 491</b>	<b>13 431</b>
	Electricity	kW	140,0	261,24	128 800	240 341	8 288
		price	1,866				
	Compressed air	n/m <sup>3</sup>	210,0	162,12	193 200	149 150	5 143
		price	0,77				
	<b>Marginal profit</b>			<b>26 668,51</b>		<b>24 535 033</b>	
	<b>Marginal profitability</b>			<b>59,3%</b>		<b>59,3%</b>	
<b>2</b>	<b>Fixed costs</b>			<b>12 013,60</b>		<b>11 052 513</b>	<b>381 121</b>
	Wage	UAN		1 436,06		1 321 175	45 558
	Salary Charges	UAN		315,93		290 659	10 023
	General shop costs	UAN		9 450,51		8 694 471	299 809
	Depreciation (for rent)	UAN		811,10		746 208	25 731
	<b>PRODUCTION COST</b>		<b>1045</b>	<b>30 295,09</b>		<b>27 871 480</b>	<b>961 086</b>
	<b>Gross profit</b>		<b>505</b>	<b>14 654,91</b>		<b>13 482 520</b>	<b>464 914</b>
	<b>Gross profitability</b>			<b>32,6%</b>		<b>32,6%</b>	

Table 15. Calculation of the cost of "ZaryaD" d = 32.42 mm

### Examination Costs

<b>Naming of expenditures</b>	<b>New equipment</b>	<b>AMONAL</b>	<b>ZaryaD</b>	<b>Total</b>
Development of design documentation			80,0	80,0
Expertise of design documentation			50,0	50,0
Expertise of the project solution		5,9	6,0	11,9
Carrying out of control tests	90,0	149,1	120,0	359,1
Determination of uncontrolled indicators		96,7	95,0	191,7
Conducting preliminary and acceptance tests	110,0	160,0	160,0	430,0
Certification, incl.				-
« Kyiv Experimental Technical Center»		55,0	55,0	110,0
«Scientific-Production Association» Pavlograd Chemical Plant «		85,0	85,0	170,0
«MINPROEKT EAD»		84,1		84,1
Examination and obtaining permits for the use of new types of substances		50,0	40,0	90,0
Examination and obtaining permission for the operation of new equipment	120,0			120,0
Production license		4,0	4,0	8,0
Permit for storage of products and raw materials (Gostrud and the Ministry of Internal Affairs)		2,5	2,5	5,0
Examination of Technical Terms		6,0	6,0	12,0
Examination of substance and Technical Terms, preparation of conclusions («Institute of labor medicine»)		6,4	6,4	12,8

Examination of Technical Terms, preparation of a conclusion on TT («Institute of Hygiene and Medical Ecology»)		5,0	5,0	10,0
Checking TT, registering («Ukrmettest standard «)		12,0	12,0	24,0
Acquisition of official copies of the Normative Documentation («Kharkov Standard-Metrology»)		10,0	10,0	20,0
Collection at the State Treasury for imprisonment		0,6	0,6	1,2
Certification of the cartridge equipment for explosion protection and for use	300,0			300,0
Primary inspection of equipment	50,0			50,0

Table 17. Costs for passing examinations, obtaining permits and licenses for production of «AMOMAL» and «ZaryaD» SCCE, ths. UAH

### Formulation of risks

Formulation of risks	Reasons (sources)	Possible consequences	Possible measures	«Price» of measures and impact on the economy of the project
<b>Production</b>				
Not achieving product quality parameters	Application of raw materials that does not correspond to quality indicators; malfunctions in equipment operation	Marketable complexities, loss of market	Careful testing of raw materials for compliance with technical requirements, flexible pricing policy	Decrease of income and profit
Failure to achieve project cost ratios	Not profitable technology	Increased direct costs	Adjustment of equipment, development of measures for optimization of expenditure norms	Increase in production cost
Significant increase in the estimated cost of construction and installation work on the project	Financial and economic instability in the state	Increase the cost of the project	Provide unforeseen expenses in the initial investment	Increase the payback period

<b>Organizational</b>				
Increase of the terms of obtaining permit documentation for the possibility of implementing the project	Changes in terms of issuance of permits by the fault of organizations	Changes in terms of start-up of the project	Provide the possibility of changing the terms at the design stage and drawing up a network schedule for the execution of works	Lack of profit due to delays in the start of production
<b>Financial</b>				
The risk of progressive inflation	Unstable macroeconomic situation in the country	Decrease of real incomes from investment capital	Accounting for macroeconomic indicators when calculating a business plan, adjusting indicators through an increased discount rate	Decrease in real profits
Increase in tax payments and other deductions directly affecting the final result	Changes in the tax rate in the unfavorable for RPE «Zarya» side and their deductions in the process of activity	Increase of production cost, decrease of profit	The possibility of changing the value of the product at the stage of conclusion of the contract	Reduced interest in products from potential customers, declining gross income.

Table 20. Comprehensive analysis of major project risks and economic implications